Faculty of Manufacturing Engineering

INVESTIGATION OF NATURAL HYBRID SANDWICH PANEL AND THIN SKIN COVER TOWARDS ACOUSTICAL PERFORMANCE

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A thesis submitted in fulfilment of the requirement for the degree of Master of Science in Manufacturing Engineering

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DECLARATION

I declare that this thesis entitled “Investigation of Natural Hybrid Sandwich Panel and Thin Skin Cover towards Acoustical Performance” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……..

Name : Paramananthan A/L Balakrishnan

Date : ……..

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Manufacturing Engineering.

Signature	:	……..……
Supervisor Name	:	Associate Professor Ir. Ts. Dr. Mohd Yuhazri Yaakob
Date	:	……..……

DEDICATION

Dedicated to my Spritual Master Guruji Shri Brahmaatmanda for His shower of blessings.

My beloved father, mother, wife, and children for giving me moral support and encouragement.

ABSTRACT

Sandwich structure is a very expensive engineering material. However, due to its multiple advantages such as light weight and high strength, its demand is relatively high. In this project, the natural material fiber was intended to replace the synthetic fiber in the core to reduce its dependency on synthetic materials. Basically, the use of natural material can minimize the cost in terms of materials and processing as well as to conserve the environment by reducing the waste of natural material. This research utilized the green natural fiber in the manufacturing of acoustic panel which must own good behavior such as the sound absorption. Furthermore, the materials and the processes involve are simple and cost effective. The materials used were coconut fiber, polystyrene, polyurethane, and polyester. The sandwich structure was done by using hand lay-up and press technique using a hydraulic press machine with 1 ton pressure. The natural acoustic panel is drilled in order to produce perforation on the surface of the panel. The parameter used in this research is the perforation of the natural fiber. The suggested diameter for the perforation is 3 mm and 6 mm. The acoustical behavior of the sandwich structure was tested by using impedance tube test. There are 23 sample designs for the core and 18 samples for the skin cover were prepared for the impedance tube testing. The impedance tube testing was used to measure the absorption coefficient of the natural fiber. Among the 23 samples that had been tested, the most suitable sample to be applied as an acoustic panel at low, medium and high frequency were S3, S13 and S14, respectively. In particular, 0.90, 0.98 and 0.85 of the absorption coefficient value at 600, 1500 and 2400 Hz, respectively. There is no or less research and testing done for the skin material. The suggested skin material also serves as a decorative and protective layer for the core or acoustic panel. The proposed material which is the cotton material with 2 layers of the same material with an 10 mm air gap in between the 2 layers and 10 mm gap to the core was recommended to be used as skin material for an acoustic core panel as the material had a very good sound absorption coefficient.

ABSTRAK

Struktur 'sandwich' merupakan bahan kejuruteraan yang sangat mahal. Walaubagaimanapun, ianya mempunyai banyak kelebihan seperti ringan dan kekuatan yang tinggi , maka permintaan terhadap struktur 'sandwich' adalah sangat tinggi. Dalam kajian ini, bahan semulajadi dipilih untuk dijadikan bahan serat pada struktur 'sandwich' untuk menggantikan bahan sintetik dan secara tidak langsung dapat mengurangkan pergantungan terhadap bahan sintetik. Secara umumnya, penggunaan bahan semulajadi juga dapat mengurangkan kos dari segi bahan mentah dan pemprosesan serta dapat memelihara alam sekitar dengan mengurangkan bahan buangan daripada sumber bahan semulajadi. Kajian ini dilaksanakan bagi memperluaskan penggunaan bahan semulajadi atau bahan hijau untuk dijadikan panel akustik yang mempunyai keupayaan yang tinggi untuk menyerap getaran bunyi. Selain itu, penggunaan bahan mentah dan proses yang digunakan dalam kajian ini adalah mudah didapati dan kos yang berpatutan. Bahan-bahan yang diperlukan untuk menghasilkan panel akustik adalah sabut kelapa, polistirena, poliuretana, dan poliester. Struktur 'sandwich' dihasilkan dengan menggunakan teknik 'hand lay-up' dan ditekan dengan mesin tekan hidraulik dengan tekanan 1 tan. Panel akustik semulajadi tersebut digerudi untuk menghasilkan lubang pada permukaan panel. Faktor yang digunakan di dalam kajian ini adalah perbezaan saiz lubang pada gentian semulajadi. Diameter yang digunakan untuk penembusan bagi akustik panel tersebut adalah 3 mm dan 6 mm. Sifat akustik yang terdapat di dalam struktur 'sandwich' akan diuji dengan menggunakan ujian tiub impedan. Terdapat 23 reka bentuk sampel'core' dan 18 sampel untuk 'skin cover' akan disediakan untuk ujian tiub impedan. Ujian tiub impedans adalah untuk mengukur pekali penyerapan gentian semula jadi. Berdasarkan ujian yang dijalankan ke atas 23 sampel tersebut sampel terbaik dan sesuai untuk digunakan sebagai panel akustik pada frekuensi rendah, sederhana dan tinggi adalah sample nombor S3, S13, dan S14 yang mana mempunyai penyerapan bunyi sebanyak 0.90, 0.98 and 0.85 pada frekuensi 600, 1500 and 2400 Hz. Tidak ada kajian yang dibuat untuk lapisan luar panel akustik sebelum ini. Lapisan kulit ataupun lapisan luar ini memainkan peranan yang penting kerana lapisan luar ini boleh juga berfungsi sebagai perlindungan dan perhiasan. Bahan yang dicadangkan sebagai kulit dalam kajian ini ialah kain kapas dimana dua lapisan kain kapas di antara dua ruang udara 10mm bagi panel akustik dimana bahan kain kapas membuktikan bahawa ianya mempunyai pekali penyerapan bunyi yang baik.

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ASTM	-	American Society for Testing And Materials
CFRP	-	Carbon Fiber-Reinforced Polymer
CMC	-	Ceramic Matrix Composite
CSM	-	Chopped Strand Mat
FRP	-	Fiber reinforced panel
GFRP	-	Glass Fiber-Reinforced Polymer
H	-	Height
ISO	-	International Standards Organization
L	-	Length
MMC	-	Metal Matrix Composite
NAC	-	Normal incidence sound Absorption Coefficient
PMC	-	Polymer Matrix Composite
PU	-	Polyurethane
RAC	-	Random incidence sound Absorption Coefficient
SMI	-	Small Medium Industry
S1	-	Sample 1
S2	-	Sample 2
S3	-	Sample 3
S4	-	Sample 4
S5	-	Sample 5

S6	-	Sample 6
S7	-	Sample 7
S8	-	Sample 8
S9	-	Sample 9
S10	-	Sample 10
S11	-	Sample 11
S12	-	Sample 12
S13	-	Sample 13
S14	-	Sample 14
S15	-	Sample 15
S16	-	Sample 16
S17	-	Sample 17
S18	-	Sample 18
S19	-	Sample 19
S20	-	Sample 20
S21	-	Sample 21
S22	-	Sample 22
S23	-	Sample 23
W	-	Width